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RESEARCH NOTE

Varying weed management treatments impact on weeds and fodder yield relationship in fodder maize

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ABSTRACT

A field experiment was conducted at Forage Research Farm, Department of Plant Breeding and Genetics, PAU, Ludhiana and Regional Research Station, Gurdaspur during the *Kharif* season of 2020 in fodder maize to evaluate the impact of different weed management treatments on the relationship amongst weed parameters, fodder maize crop characters and green fodder yield. Green fodder yield of maize showed a significant positive correlation with weed control efficiency, maize plant dry weight and plant height. On the contrary, these parameters were negatively correlated with the weed density and biomass at the knee high stage of the crop. The average of the two locations indicated that a unit increase in weed density and biomass reduced maize fodder yield by 0.0655 and 0.083 t/ha, respectively. Similarly, the increase in the maize fodder yield due to a unit increase in weed control efficiency was estimated at 0.166 t/ha.

Keywords: Cultivars, Green fodder yield, Inter cropping, Maize, Row spacing, Tembotrione, Weed management

Maize (*Zea mays* L.) is the second most important crop in world in terms of production. In India, maize is the third major crop after rice and wheat. Amongst the varied uses of this crop, its use as green fodder has attracted substantial attention from farmers as well as scientists. The fodder quality of green maize is considered best among non-legume forage crops. Maize is considered ideal forage because it is fast growing and, produces high yields, palatable, rich in nutrients, and helps to increase body weight and milk quality in cattle (Hanif and Akhtar 2020). As fodder for livestock, maize is excellent, highly nutritive and sustainable. It is commonly grown as a summer and *Kharif* fodder in the north-western regions of India. Its quality is much better than sorghum and pearl millet as both sorghum as well as pearl millet has anti-quality components such as hydrocyanic acid and oxalate, respectively.

Maize productivity is limited by a number of factors and the leading one amongst them is the weed infestation. Being a wide row spaced crop along with regular rains especially in *Kharif* season, weeds inflict yield losses up to 68.9% (Sunitha *et al*. 2010, Singh *et al*. 2016). Maize is infested with a variety of weed flora including annual and perennial grasses, sedges and broad-leaved weeds. The critical period of crop-weed competition starts at 30 days after sowing and ends at 60 days after sowing in Northern part of India (Singh *et al.* 2016). Presently, the commonly adopted weed control option in fodder maize is limited to the use of herbicides particularly the pre-emergence herbicides. The adoption of other non-chemical weed management methods is lacking. The objective of the present study was to evaluate the cultivars, row spacings, herbicides and intercropping to manage weeds in fodder maize and to study the relationship amongst weed density and biomass and weed control efficiency with green fodder yield and yield attributing characters of fodder maize.

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Field experiment was conducted at Fodder Research Farm, Punjab Agricultural University, Ludhiana and Regional Research Station Gurdaspur during *Kharif* season of 2020. Ludhiana and Gurdaspur are located at 30^{0}54’N75^{0}48’E and 31^{0}55’N75^{0}15’E, respectively. The prevailing weather during the cropping season at Gurdaspur and Ludhiana is presented in **Figure 1**.

The experiment was laid out in split plot design with two cultivars (J1006 and J1007) and two row spacings (30 and 22.5 cm) in main plots and six weed control treatments in sub plots (weedy check, weed free, pre-emergence application (PE) of atrazine 625 g/ha, post-emergence application (PoE) of tembotrione 120 g/ha, maize +cowpea and maize + *guara*). Pre-emergence application of atrazine was done on next day of sowing while post-emergence application of tembotrione was done at 20 DAS or 3-4 leaf stage of weeds with the help of manually operated knapsack sprayer fitted with flatfan nozzle using 500 liters of water/ha. The crop was sown in

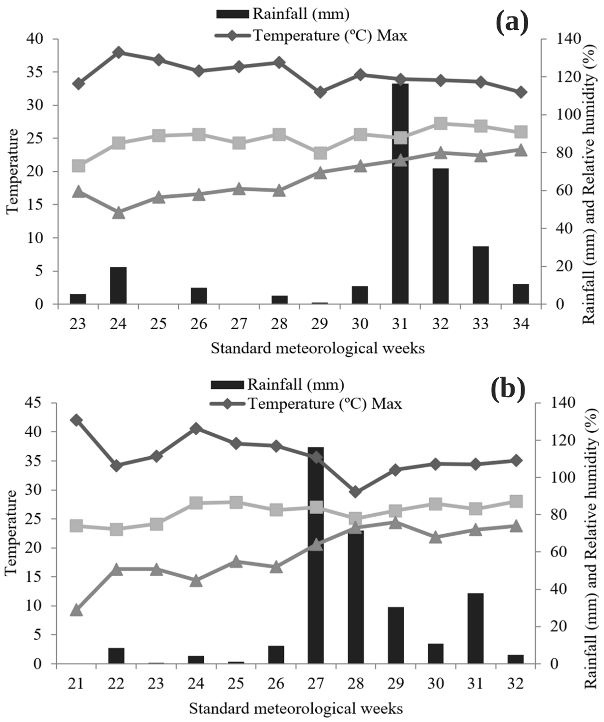


Figure 1. Weekly weather parameter during the crop season at (a) Gurdaspur and (b) Ludhiana

the last week of May at both the locations. A manual hand drill was used for sowing the seed in opened furrows at a depth of 4-6 cm with row spacing as per the treatments. The seed rate for 30 cm row spacing and 22.5 cm row spacing was 75 kg/ha and 90 kg/ha, respectively. For intercrop sowing one row of cowpea and guara as per the treatments were sown in between the maize rows. The crop was fertilized with 87.5:30:20 kg N:P:K/ha through Urea, Single Super Phosphate, Muriate of Potash respectively. One third dose of N and entire dose of phosphorus and potassium was drilled at the time of sowing. The crop was irrigated as when required and depth of each irrigation was 5 cm. The area of each treatment combination was 12 m^2 (4 x 3m) and with three replications. The crop was harvested for taking green fodder yield at dough stage of 78 days after seeding (DAS) at both Ludhiana and Gurdaspur. Maize and intercrops were harvested separately from plots by using sickle. The observations on yield attributes and green fodder yield were recorded at harvest. Maize equivalent green fodder yield was calculated to compare the weed control treatments by converting the green fodder yield of intercropping treatments into maize equivalent green fodder yield based on the prevailing market prices. The density and biomass of weeds were recorded at the knee high stage of the crop corresponding to 35-40 days after sowing (DAS) by placing the quadrat following standard procedure. The mean data of three replications of weed density, weed biomass and weed control efficiency (WCE) were correlated with yield attributes and yields. WCE was computed using weed biomass in treated plots compared to weedy check. Statistical analysis of the data was done using analysis of variance in split plot using OPSTAT software and statistical mean differences were found by Fisher's protected least significant difference test at $p<0.05$. The relationship of weed density, weed dry weight and WCE with green fodder yield was described by using linear regression models.

At the knee high stage of the crop, both the cultivars responded similarly against weed competition at both Gurdaspur and Ludhiana (**Table 1**). Statistically non-significant differences were observed in weed density and biomass at both the locations with the tested two fodder maize cultivars although both weed density and biomass remained comparatively lower in J1007. Nonetheless, a significantly higher maize equivalent green fodder yield (6-7%) was recorded with J1007 due to differential competing ability, inherent genetic yield potential, vigorous crop growth in terms of the plant height and dry weight accumulation which led to more smothering effect on the weeds growing beneath and thus higher yields (Kumar *et al.* 2013).

Row spacings differed significantly in influencing the density and biomass of weeds both at Gurdaspur and Ludhiana (**Table 1**). As compared to wider row spacing, there was significant reduction of 21.3% in weed density and 22.2% in weed biomass in narrow row spacing at Gurdaspur. Similarly, at Ludhiana, weed density decreased significantly by 21.2% and weed biomass by 19.8% in narrow row spacing over the wider rows. This could be possibly due to lesser space available for the weeds to grow in narrow rows of the crop. Narrow row spacing had WCE of 72.5% at Gurdaspur and 70.5% at Ludhiana while the values of WCE for wider rows were 64.8% at Gurdaspur and 63.4% at Ludhiana. Maize equivalent green fodder was observed to be significantly more when the crop was sown in narrow row spacing as compared to the crop sown in wider row spacing. A lesser weed density and biomass in narrow crop rows indicated increased crop competitiveness against weeds (Chauhan and Johnson 2011). This might have led to better utilization of different growth resources by the crop which was ultimately reflected in increased green fodder yield in narrow rows.

Among the different weed control treatments, at the knee high stage of the crop, significantly minimum density and biomass of all types of weeds was recorded in weed free and maximum in un-weeded control at both the locations (**Table 1**). Among the herbicide treatments, significantly higher reduction in weed density and biomass was observed with tembotrione 120 g/ha PoE at Gurdaspur. A significant reduction in density and biomass of grasses and broad-leaved weeds with tembotrione 110 and 120 g/ha was also reported by Kaur *et al.* (2018). Atrazine 625 g/ha PE was found to be at par with maize + cowpea intercropping in the reduction of weed density and biomass. Similar trend was observed at Ludhiana and Gurdaspur. At both the locations, the green fodder yield of maize was significantly highest in weed free treatment followed by the plots treated with tembotrione 120 g/ha. Atrazine 625 g/ha PE and maize sown in intercropping with cowpea recorded statistically similar green fodder yields. While significantly lowest green fodder yield of maize was observed in the weedy plots.

The correlation matrix (**Table 2**) revealed that the density and biomass of weeds were negatively correlated with green fodder yield at both the locations while maize plant dry weight, plant height and WCE had significant positive correlation with green fodder yield (**Table 2**). The highest degree of positive association was observed between weed density and biomass (r = 0.892** at Gurdaspur and r = 0.979** at Ludhiana). This was followed by the correlation of WCE with green fodder yield (r = 0.849**) at Gurdaspur and correlation of plant height with green fodder yield (r = 0.885**) at Ludhiana. In all the cases, the correlations were highly significant *i.e.* at 1% probability level. The correlation coefficients amongst WCE, plant dry weight, plant height and fodder yield were positive (r = 0.562 to 0.849 at Gurdaspur; r = 0.710 to 0.885 at Ludhiana).

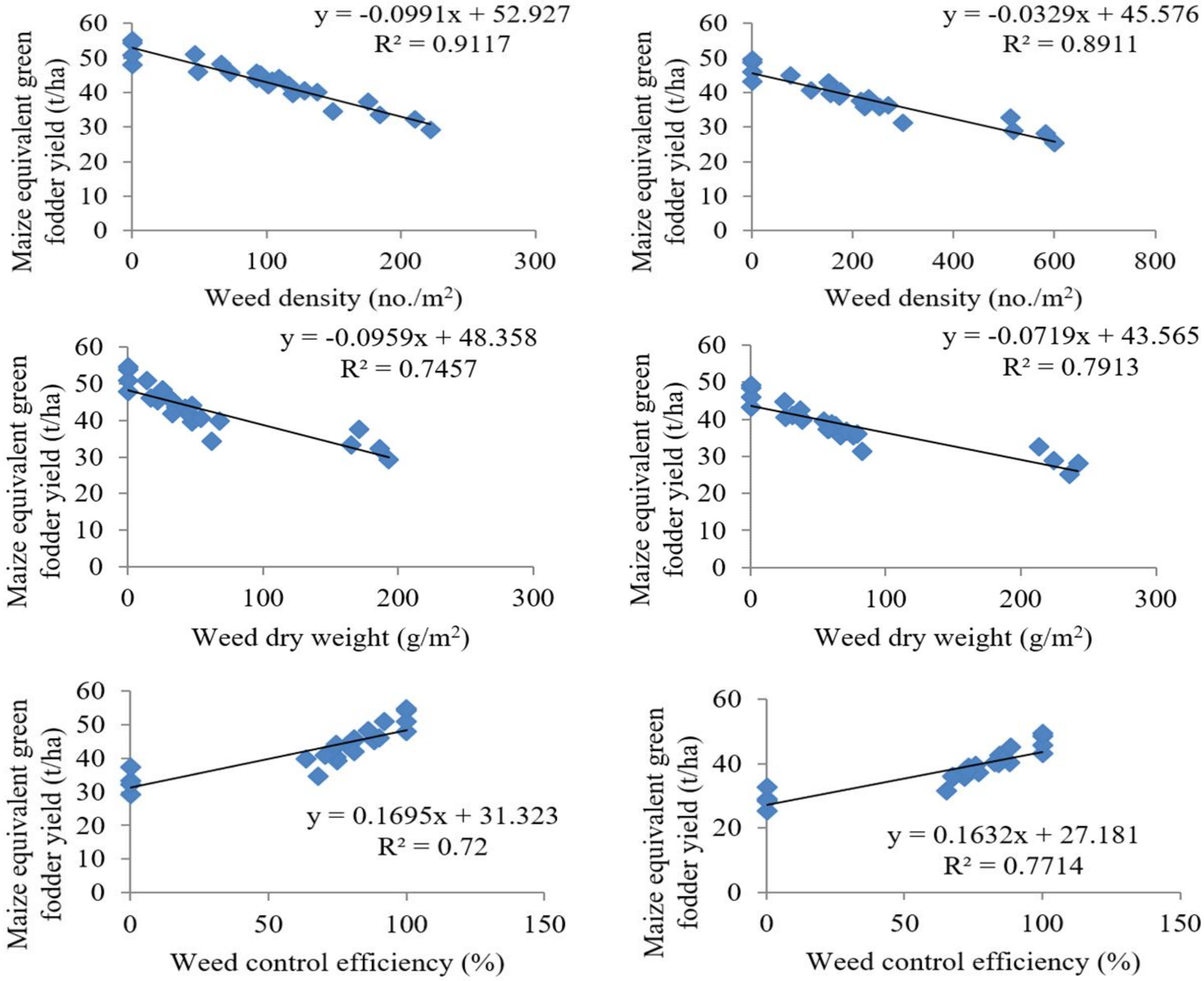
The regression analysis of maize equivalent green fodder yield as affected by weed density and biomass also confirmed the negative relationship between these parameters (**Figure 2a** and **2b**). The regression equation predicted a linear reduction in the green fodder yield with a unit increase in the density and dry weight of weeds (Soni *et al*. 2021). The magnitude of reduction could be 0.099 and 0.095 t/ha for weed density and biomass at Gurdaspur and 0.032 and 0.071 t/ha for weed density and biomass at Ludhiana. The reduction in fodder yield could mainly be attributed to reduction in the yield attributing parameters, *viz.* plant dry weight and plant height as indicated by the correlation coefficients. The regression analysis of green fodder yield with WCE

Table 1. Weed density and biomass, weed control efficiency at knee high stage and maize equivalent green fodder yield as affected by different weed management treatments at Gurdaspur and Ludhiana

Treatment	Weed density (no./m^2)		Weed biomass (g/m^2)		WCE (%)		Green fodder yield (t/ha)	
	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhian
Cultivar								
J 1006	9.27 (103.3)	13.53 (229.1)	6.59 (56.7)	7.74 (77.1)	68.3	65.6	41.61	37.14
J 1007	9.02 (97.1)	13.09 (216.5)	6.48 (55.3)	7.27 (70.7)	69.1	68.4	44.37	39.37
LSD (p=0.05)	NS	NS	NS	NS			1.57	1.45
Row spacing (cm)								
30	9.69 (112.2)	14.17 (249.2)	7.02 (63.0)	8.02 (82.0)	64.8	63.4	41.09	36.45
22.5	8.61 (88.3)	12.45 (196.4)	6.05 (49.0)	6.99 (65.8)	72.6	70.5	44.90	40.05
LSD (p=0.05)	0.41	0.73	0.25	0.48			1.57	1.45
Weed control								
Weedy check	14.06 (197.9)	23.53 (553.8)	13.40 (179.0)	15.15 (229.1)	0.0	0.0	33.06	28.75
Weed free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	100.0	100	51.88	46.70
Atrazine 625 g/ha	10.23 (103.9)	13.93 (194.9)	6.44 (40.8)	7.18 (51.9)	77.2	77.3	43.25	38.40
Tembotrione 120 g/ha	7.62 (58.9)	11.14 (126.3)	4.42 (19.5)	5.62 (31.3)	89.1	86.3	47.70	41.98
Maize + cowpea	10.71 (114.4)	14.38 (207.6)	6.73 (44.8)	7.70 (60.7)	75.0	73.4	42.46	37.89
Maize + guara	11.26 (126.4)	15.89 (254.2)	7.20 (51.8)	8.39 (70.4)	71.1	69.2	39.59	35.80
LSD (p=0.05)	0.65	0.81	0.64	0.71			1.29	1.18

Table 2. Correlation coefficient (r) values of weed density, weed biomass, weed control efficiency with yield and yield attributing characters of fodder maize at Gurdaspur and Ludhiana

Parameter	Weed density		Weed biomass		Weed control efficiency		Plant dry biomass		Plant height		Fodder yield	
	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana	Gurdaspur	Ludhiana
Weed density	1.000	1.000	0.892**	0.979**	-0.881**	-0.974**	-0.888**	-0.779**	-0.732**	-0.812**	-0.955**	-0.944**
Weed biomass	0.892**	0.979**	1.000	1.000	-0.996**	-0.998**	-0.775**	-0.715**	-0.675**	-0.716**	-0.864**	-0.890**
Weed control efficiency	-0.881**	-0.974**	-0.996**	-0.998**	1.000	1.000	0.784**	0.723**	0.668**	0.710**	0.849**	0.878**
Plant dry biomass	-0.888**	-0.779**	-0.775**	-0.715**	0.784**	0.723**	1.000	1.000	0.562**	0.783**	0.835**	0.772**
Plant height	-0.732**	-0.812**	-0.675**	-0.716**	0.668**	0.710**	0.562**	0.783**	1.000	1.000	0.787**	0.885**
Fodder yield	-0.955**	-0.944**	-0.864**	-0.890**	0.849**	0.878**	0.835**	0.772**	0.787**	0.885**	1.000	1.000



(a) Gurdaspur (b) Ludhiana

Figure 2. Regression analysis of maize equivalent green fodder yield (t/ha) as affected by weed density, weed dry weight (biomass) and weed control efficiency at (a) Gurdaspur and (b) Ludhiana

revealed that 1% increase in the WCE led to an increase of 0.169 t/ha in the green fodder yield at Gurdaspur and an increase of 0.163 t/ha at Ludhiana. The increase in yield by unit increase in WCE was also reported by Yadav *et al* (2015).

It may be concluded that suppression of weed density and biomass by cultivar J1007 was greater than J1006, although the differences were statistically non-significant. The cultivar J1007 also recorded higher green fodder yield than J1006. Further, the control of weeds at critical stages by the use of narrow row spacing or herbicides or intercropping increased the WCE which in turn enhanced the crop competitiveness and yield attributes resulting in higher green fodder yield of maize.

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